Part 1

At the begining, instead of creating new sequence of smoothed images, I smooth the frames on the fly.

Every time two frames are loaded in function compute_LK_optical_flow, they will be smoothed by the method that I copied from smooth_frames.m.

Then I calculate "Ix", "Iy" of the first frame using gradient function. I also calculate "It", the difference beween the first frame and the second frame.

Next, I need to apply formula

$$\begin{bmatrix} \sum(\frac{\partial I^n}{\partial x})^2 & \sum(\frac{\partial I^n}{\partial x})(\frac{\partial I^n}{\partial y}) \\ \sum(\frac{\partial I^n}{\partial x})(\frac{\partial I^n}{\partial y}) & \sum(\frac{\partial I^n}{\partial y})^2 \end{bmatrix} \begin{bmatrix} v_x \\ v_y \end{bmatrix} = - \begin{bmatrix} \sum(I^n(x,y) - I^{n+1}(x,y))\frac{\partial I^n}{\partial x} \\ \sum(I^n(x,y) - I^{n+1}(x,y))\frac{\partial I^n}{\partial y} \end{bmatrix}$$

to get vx,vy.

I iterate every pixels expect the ones in boundary, Calculate the range of its window,

```
dx=Ix(j-w:j+w,i-w:i+w);
dy=Iy(j-w:j+w,i-w:i+w);
dt=simt(j-w:j+w,i-w:i+w);
```

then calculate the sum of (d/dx)^2, sum of (d/dy)^2, (d/dx)*(d/dy) also the sum of It*(d/dx) and sum of It*(d/dx) for each window of pixel.

```
A=[sum(sum(dx.^2)) sum(sum(dx.*dy));sum(sum(dx.*dy)) sum(sum(dy.^2))];
B=[sum(sum(dx.*dt));sum(sum(dy.*dt))];
```

After smooth the RHS,

```
B=smoothdata(B,1,'gaussian','SmoothingFactor',sigma_1d);
```

I use linsolve to obtain vx and vy, adding negative to make the plot right.

Further disscussion

I notice that when the window size = 31*31, the function gives the best result.

When the window is small, the filed will not be sensitive to the motion, and the arrows will only shows the large motions

Windows size=7*7

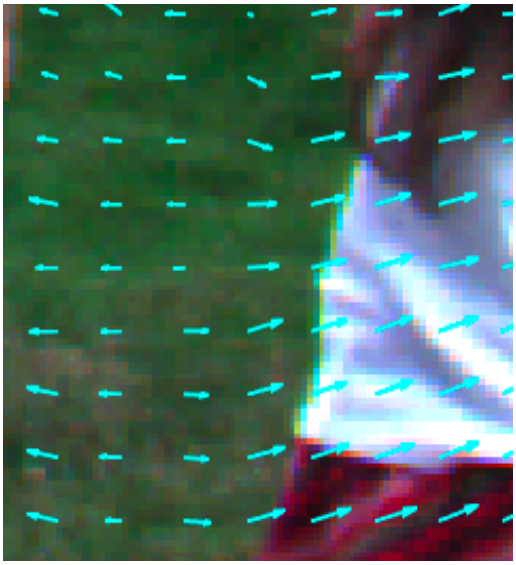
Details:

Even if the little girl is turning right, the motion field of this area is not responding to the it.

And when the window is too large, it breaks the assumption of Lukas-Kanade algorithm that window size should be small. motion field of some point will be mislead by other motions that happened near it.

Windows size=41*41

Details:



The motion field on the little girl detected the girl's movement, but the motion field on pixel that beside the girl also responds to the girl's movement. The result is not accurate.

For the Smooth factor Omega, there will be little difference in result when using different value of Omega. The difference is not significant.